SpiderFab: Architecture for On-Orbit Construction of Kilometer-Scale Apertures

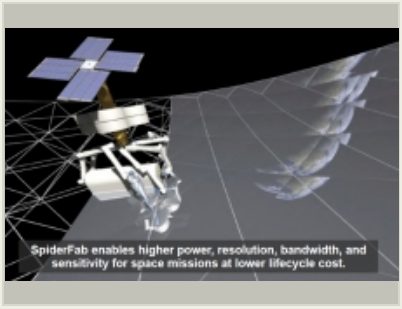
Completed Technology Project (2013 - 2015)

Project Introduction

The SpiderFab effort has investigated the value proposition and technical feasibility of radically changing the way we build and deploy spacecraft in order to escape the size constraints and cost scaling of current space systems. The vision that has motivated this effort is that of creating a satellite 'chrysalis', composed of raw material in a compact and durable form, 'software DNA' assembly instructions, and the capability to transform itself on-orbit to form a high-performance operational space system. SpiderFab enables this transformational capability by adapting additive manufacturing techniques and robotic assembly technologies to fabricate and integrate large space systems on-orbit. Fabricating spacecraft components on-orbit enables order-of-magnitude increases in packing efficiency and structural performance. These improvements will enable NASA to escape the volumetric limitations of launch shrouds to create systems with extremely large apertures and very long baselines. The larger solar panels, antennas, booms, concentrators, and optics created with SpiderFab will deliver higher power, higher resolution, higher bandwidth, and higher sensitivity for a wide range of missions. Our Phase I analyses have established that on-orbit fabrication changes the cost equation for large space systems, enabling apertures to scale to hundreds or even thousands of meters in size while providing order-of-magnitude improvements in system performance-per-cost. The transition potential of the SpiderFab concept is demonstrated by the fact that our Phase I NIAC effort has already resulted in a successful transition to post-NIAC efforts under a NASA/LaRC SBIR to further develop a process for on-orbit fabrication of support structures for high-power solar arrays. The proposed Phase II NIAC effort will build upon this success by developing and demonstrating methods to address the key risk of fabrication in the thermal and vacuum environment of space. It will also develop to PDR-level a concept design for a mission to demonstrate on-orbit fabrication and integration of a large RF aperture, and establish the value proposition for this capability by comparing key performance-to-cost metrics relative to conventional deployable technologies.

Anticipated Benefits

This project has the potential to dramatically reduce the the costs of space systems through on-orbit fabrication of several different kinds of large space system components. On-orbit fabrication can dramatically improve structural performance and packing efficiency and provide order-of-magnitude improvements in key system metrics.



Project Image SpiderFab: Architecture for On-Orbit Construction of Kilometer-Scale Apertures

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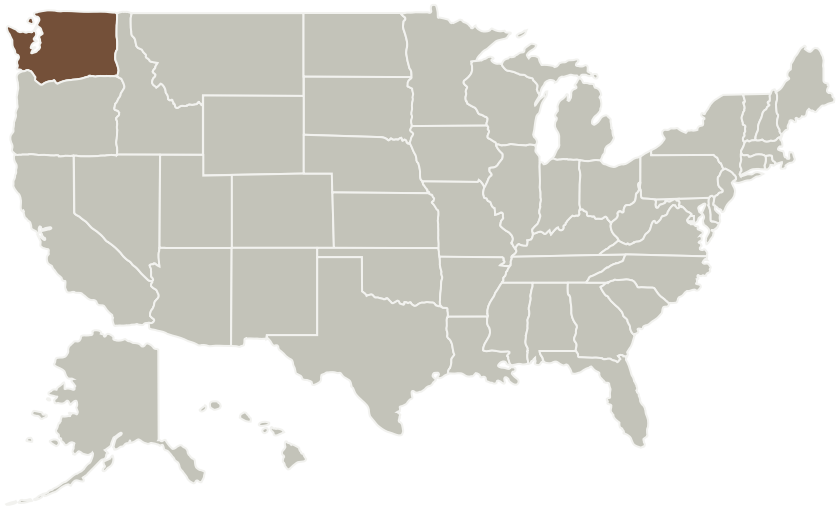
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Tethers Unlimited Inc	Lead Organization	Industry	

Primary U.S. Work Locations
Washington

Project Transitions

September 2013: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Tethers Unlimited Inc

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

Eric A Eberly

Principal Investigator:

Robert Hoyt

Co-Investigator:

Jeffrey Slostad

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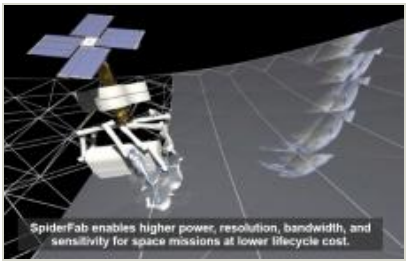
September 2015: Closed out

Closeout Summary: The SpiderFab effort has investigated the value propositio n and feasibility of radically changing the way we build and deploy spacecraft by enabling space systems to fabricate and integrate key components on-orbit. In t his Phase II effort, we have focused on developing and demonstrating tools and processes to enable robotic systems to manufacture and assemble highperforma nce structural elements that will serve as the support structures for components such as antennas and solar arrays. Through testing of these technologies in the l aboratory environment, these efforts have established the technical feasibility of the key capabilities required for in-space manufacture of large apertures such as antennas, solar arrays, and optical systems, maturing prototype technical soluti ons for these capabilities to TRL-4. The SpiderFab effort has resulted in successf ul post-NIAC transition of the technology, first to SBIR-funded development of a technology for in-space manufacture (ISM) of truss structures, and then to a NA SA/STMD TP Technologies funded effort to prepare a flight demonstration of ISM of a structure for a GEO communications satellite.

Images



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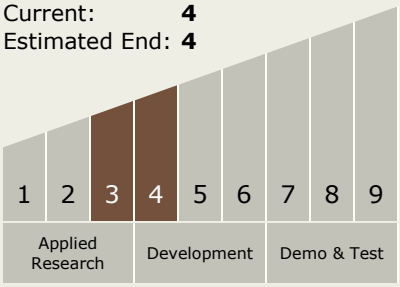
Project Image SpiderFab: Architecture for On-Orbit Construction of Kilometer-Scale Apertures
(https://techport.nasa.gov/image/102206)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.4 Advanced Propulsion
    - TX01.4.4 Other Advanced Propulsion Approaches

Target Destination

Earth